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H233 H246
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(56) Documents Cited
GB 2186769 A **EP 1168888 A2**
EP 0524537 A2 **US 5446576 A**

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INT CL^7 **H05B 3/84**
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OPTICS:H5H, WPI

(54) Abstract Title
Electrically heated zones in windscreen with transmission window

(57) Laminated windscreens with an electrically conductive coating between layers of the windscreen are commonly provided with one or more small apertures or transmission windows in the coating to allow the passage of electromagnetic radiation. The present invention reduces the formation of localised hot spots in such heated windscreens by dividing the conductive coating 2 into at least two zones 7, 8, 9 separated by divisions 10, 11 in the coating, and arranging the busbars so as to ensure a smooth current distribution within each zone. The transmission window 6 may be located in a central zone 8 of the windscreen and the adjacent busbar 4 placed around three sides of the window. In a preferred embodiment the voltage applied in this central zone is set by means, for example, of resistors 12 and 13 (fig.3) so as to maintain approximately equal temperatures in all the zones.

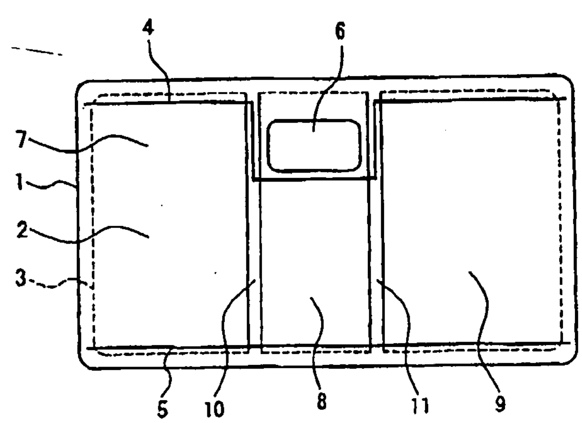

Figure 2

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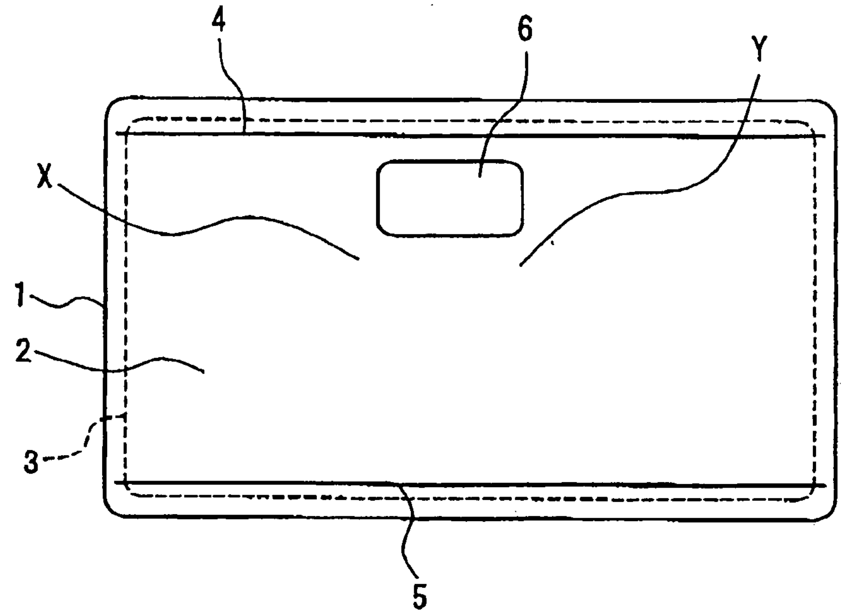

Figure 1

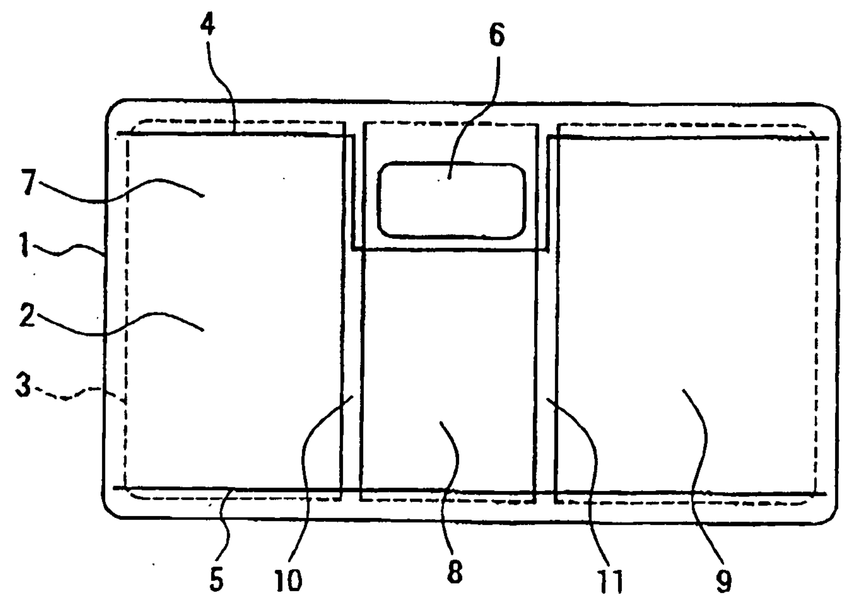

Figure 2

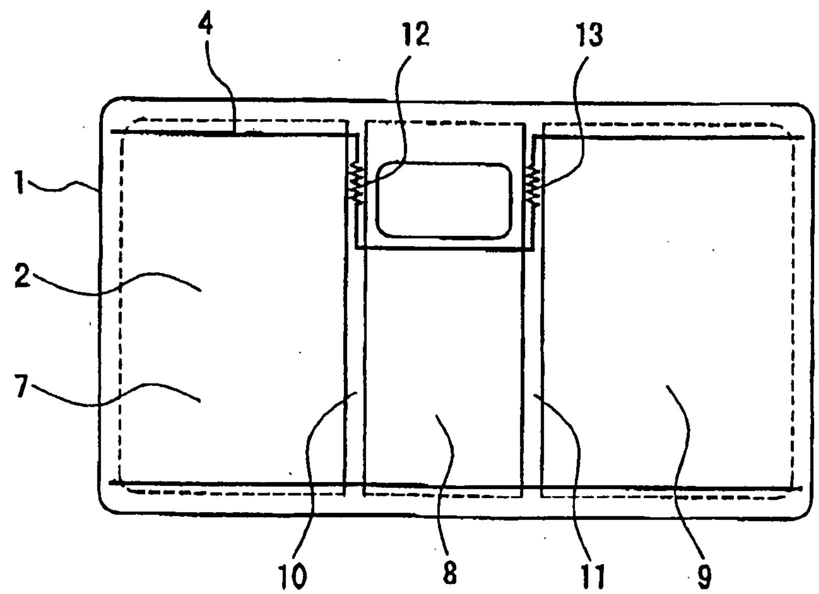

Figure 3

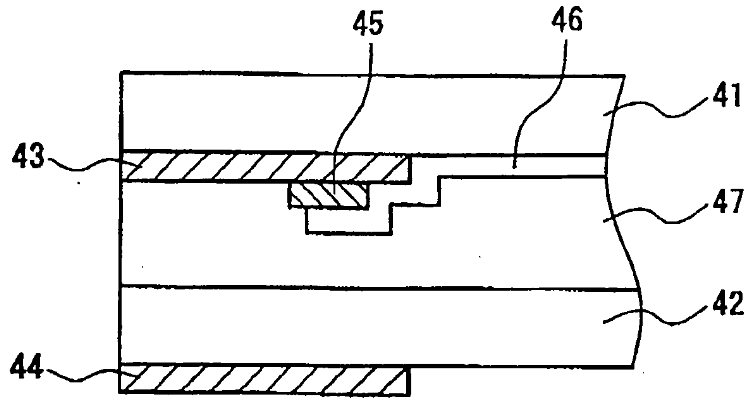

Figure 4

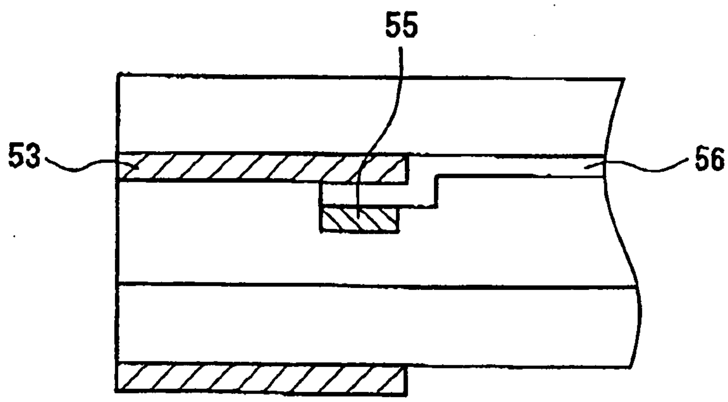

Figure 5

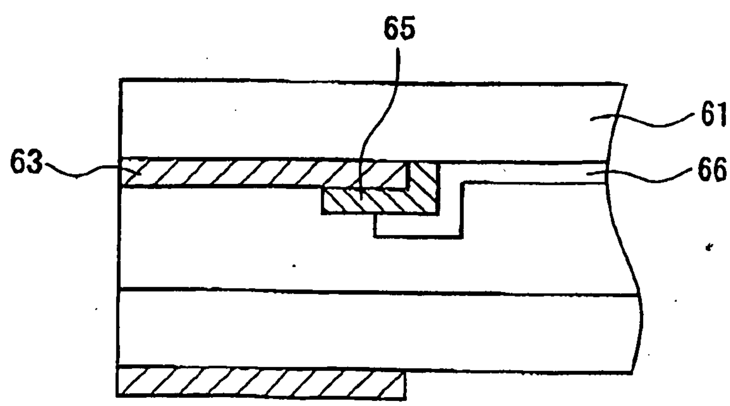

Figure 6

ELECTRICALLY HEATED WINDOW

This invention relates to an electrically heated window and in particular to a window which is heated by the passage of an electric current across a conductive coating. The invention finds particular application in vehicle glazing and especially in vehicle windscreens. The invention will hereinafter be described with particular reference to windscreens although it will be appreciated that it is useful in any electrically heated window.

Laminated windscreens having a conductive coating between the two glass sheets are increasingly used in modern vehicles. Coatings which reflect a portion of the incident infra red radiation are used to reduce the overheating in the interior of the vehicle. Such coatings may be intrinsically conductive or may be used in combination with a conductive coating. These coatings normally extend over the whole or substantially the whole of the light transmitting portion of the windscreen so as to maximise the amount of radiation which is reflected.

Such coated screens are commonly provided with one or more small apertures in the coatings which allow the passage of electromagnetic radiation. These apertures, which are known as transmission windows, are provided so as to allow sensors inside the vehicle to be addressed by signals transmitted from outside or for devices inside the vehicle to transmit signals through the window . Examples of devices which utilise such signal transmission from or to a vehicle include automatic toll payment equipment, door openers, cellular telephones, intelligent traffic signals, radar, ground position sensors, rain sensors and vehicle information communication centres. The windows may take the form of islands in the coated area or of areas located beyond the boundary of the coated area.

If the windscreen is to be heated by passing an electric current across the conductive coating an electrical circuit is normally provided by positioning at least one pair of conductive strips at opposite sides of the area to be heated and applying a voltage across those strips. These conductive strips are known and will hereinafter be referred to as busbars. The busbars in a windscreen are normally arranged as elongate strips extending along the top and bottom edge of the windscreen i.e. along the two longer edges so as to heat substantially the entire area of the windscreen whilst using the smallest possible separation between the busbars. The busbars are thereby positioned out of the driver's field

of vision at a point where they can be hidden from the view of an observer who is either inside or outside the vehicle.

A problem which may occur when a voltage is applied between the busbars is that of uneven heating of the coating leading to the formation of hot spots i.e. areas of the windscreen which are significantly hotter than the surrounding areas. This problem is significantly exacerbated by the presence of a transmission window in the area between the busbars. The aperture interrupts the even flow of the current between the busbars and the result is the formation of significant hot spots. The local temperatures at these hot spots may cause optical distortion or damage the coating or other flammable material in a laminated windscreen and are thereby undesirable. Whilst these local temperatures could be reduced by reducing the electrical power which is applied this would reduce the temperature at other cooler parts of the windscreen.

International Patent Application WO 00/72635 proposes one solution to this problem which comprises providing an electroconductive band (i.e. a band having a conductivity which is greater than that of the conductive coating) at the periphery of the transmission window.

We have now discovered that the problems caused by the formation of hot spots in a heated windscreen may be addressed by dividing the conductive coating into a series of zones each one being electrically isolated from the neighboring zone or zones and positioning the busbars within each so as to permit the even flow of current between them.

Thus from one aspect this invention provides an electrically heated window comprising at least one pane of transparent material and having an electrically conductive coating on at least one surface and at least two spaced busbars in electrical contact with that coating which is characterised in that the coating in the area between the busbars is divided into at least two zones each zone being electrically isolated from the neighboring zone or zones and positioning the bus bars so as to permit the even flow of current between them.

The invention finds particular application in electrically heated windows which have a tendency to form hot spots on heating. Such hot spots may be formed because the electrical resistance between the busbars is not distributed uniformly. The non-uniformity may be due to a number of factors. The busbars may not be parallel; the window may be curved or the coating may be discontinuous e.g. if a transmission window is present. In the glazings of the present invention the coating is preferably divided into zones in which the resistance between the busbars in each or as many as possible of the zones is substantially

uniform. This uniformity may be achieved for example by arranging that within each zone the busbars are mounted in parallel and that the edges of the zone are parallel to one another. In a flat rectangular glazing embodiment the zones will be rectangular . In a glazing such as a vehicle windscreen the glass may be curved and one edge of the glass usually the bottom edge may be longer than the top edge shape of the zones will approximate to that of a trapezium.

A particular cause of non-uniformity of the electrical resistance in known windscreens is the presence of a transmission window. In some known windscreens the window is situated at the periphery of the coated area and the busbar deviates from the top edge of the coating and passes around three sides of the window. The distance between the busbars is not uniform and hence the resistance between them is non-uniform. In another known type of screen the transmission window is surrounded by the coating. The busbars extend above and below the transmission window. The resistance between the busbars is not uniform because the coating is interrupted by the uncoated transmission window.

In the preferred embodiments of this invention the coating is divided into zones such that the transmission window and the area immediately surrounding it is contained in one zone. As the transmission window will normally be in the centre of the screen the coating is preferably divided into at least three zones with the transmission window situated in the centre of the three zones.

The zones into which the coating is divided are preferably electrically isolated from the adjacent zone or zones. The electrical isolation need not be total. However any contact between the coating across the divisions is preferably kept to a minimum as the flow of current at such points of contact may lead to the formation of a hot spot The division between the zones will preferably be bridged by the busbar .

The zones in the coating may conveniently be defined by divisions in the coating running between the busbars. The width of the division between the zones should preferably be below the boundary of perception e.g. by a driver of a vehicle looking through a windscreen. Generally the width of the division between the zone will be in the range 1 to 100 microns and preferably it will be in the range of 1 to 45 microns. The division may take the form of a single line of appropriate width. They may also take the form of a plurality of narrow lines spaced a short distance apart the whole occupying a width of from 1 to 100 microns e.g three divisions of 10 microns each separated by 5

microns from each other. In the less preferred embodiments where the width of the division between the zones is perceptible that width may be much wider, perhaps as great as 10 mm.

The zones in the coating may be formed e.g. by applying the coating by sputtering through a mask. Alternatively the zones may be separated by selectively removing a strip of the cutting from a coated substrate. One preferred means of ablating the coating in this way is the use of a laser.

Where the coating is discontinuous e.g. by virtue of the provision of a transmission window it is preferred to isolate that discontinuity within a single zone in the coating. The transmission window in conventional windscreens is situated at or near to the top of the windscreen. In the windows of this invention where a discontinuity such as a transmission window is situated at or close to the top of the heated zone we prefer to locate a potion of the upper bus bar underneath the discontinuity. This arrangement facilitates the control of hot spot formation and this advantage outweighs any disadvantage which may occur because an area of the coating immediately above the discontinuity is no longer directly in the path between the busbars. In this embodiment the distance between the busbars in the zone containing the transmission window is less that the distance between the busbars in the adjacent zones. As a result the application of a voltage between the busbars leads to the heated area of this central zone reaching a higher temperature than the neighbouring zones. This may be useful in that the central zone will demist more rapidly. However in another embodiment of this invention the glazing further comprises means for regulating the voltage applied between the busbars in each zone separately. The temperature reached in any particular zone of the windscreen may be controlled by regulating the voltage which is applied across that zone. In the embodiment described above a lower voltage may be applied across the zone containing the transmission window such that it reaches a temperature which is the same as that reached in the adjacent zones. As most vehicles have fixed voltage systems one useful way to achieve a lower voltage is to dissipate the excess voltage at another part of the windscreen or in another electrical component. For example if it is found that the optimum voltage for any particular heating zone is 36 volts then 6 volts are free to be dissipated in another electrical resistance circuit. Examples of suitable resistance circuits are printed circuits on glass surfaces for windshield wiper de-icing or the heating circuits of vehicle rear view mirrors.

The coatings useful in the heated windows of this invention typically have a resistance in the range 1.5 to 20 ohm/sq and more usually in the range 1.5 to 10 ohm/sq.

The voltages applied across the busbars will normally be in the range 36 to 72 volts. In the case of heated windscreens vehicle manufacturers are increasingly installing systems capable of delivering 42 volts.

The electrically heated glazing of the present invention may comprise a single sheet of transparent material having a conductive coating applied to one surface thereof. More commonly and particularly in the case of vehicle windscreens the glazings are of a laminated construction comprising at least two sheets of transparent material bonded to each other through an interlayer which interlayer commonly comprises polyvinylbutyral (hereinafter for convenience PVB). The transparent material is most commonly glass but plastic materials such as polyester, polycarbonates, polyacrylates and polymethacrylates may also be employed.

In the case of laminated glazings the conductive coating will normally be disposed on the inner surface of the glass (i.e. on surface 2 or surface 3 of the laminate) or on a surface of or incorporated into the interlayer.

The conductive coating may comprise a single layer of a metal or a conductive metal compound. Silver, gold, copper, nickel and chromium may be used to form transparent conductive layers. Indium oxide, indium tin oxide, antimony oxide and the like may also be used. In automotive glazings and particularly in windscreens a preferred type of coatings are those known and used in the art to reflect sunlight and thereby reduce the heating of the interior of the vehicle. These known solar control coatings typically comprise at least one metal containing conductive layer sandwiched between two layers of a dielectric. Coatings comprising one or two layers of silver sandwiched between layers of a dielectric such as tin oxide or zinc oxide are typical of these known conductive coatings.

These coatings may be deposited on the substrate using a variety of known techniques. A commonly used procedure is sputter coating. The coatings may be deposited onto the transparent substrate. Where that substrate is glass it is preferred to deposit a barrier layer onto the glass prior to the deposition of the conductive layer in order to produce migration of alkali metal cations from the glass into the conductive layer. An alternative comprises depositing the coating onto the surface of a suitable carrier film such as a PET carrier film. The coated carrier film may then be sandwiched between two sheets of PVB to form an interlayer comprising a conductive coating.

The busbars must be positioned so as to be in electrical contact with the conductive coating layer. They will normally be positioned towards the edge of the glazing. The

busbars may take the form of electrically conductive silver containing enamel layers or the form of metal foil strips such as are described for example in USP 3612745 or may be deposited by vapour deposition using the processes described in USP 6204 480. The busbars are equipped with electrical connectors enabling them to be incorporated into a power circuit.

The glazing of this invention preferably comprise a means for regulating the voltage which is applied across each separate zone of the coating. This means could comprise a least one of the busbars being split into separate sections which are addressed by separate power circuits. Such means are less preferred particularly in vehicle glazings if only because they require the provision of separate connections to each section of the busbar.

In a preferred embodiment both busbars are continuous and are incorporated into a single power circuit. The voltage applied between the busbars is regulated by varying the resistance of different sections of at least one and usually only one of the busbars. The resistance of the busbar may be varied by a variety of means. A resistor can be incorporated into the busbar at a preselected point or the nature of and/or the thickness of the busbar may be varied locally to increase or decrease the resistance. Most preferably these variations in the resistance will be located at or adjacent to the divisions between the zones in the conducting coating. The resistance of the busbar within each zone is preferably not subject to any significant variation in order to maintain a uniform voltage across that zone.

The invention will now be further described by way of the following specific embodiments with reference to the accompanying drawings in which

Figure 1 is a diagrammatic representation of a conventional heated coated windscreen.

Figure 2 is a diagrammatic representation of a windscreen according to one embodiment of this invention.

Figure 3 is a diagrammatic representation of a windscreen according to a second embodiment of the invention.

Figure 4, 5 and 6 are cross sectional views of a laminated windscreen showing three alternative constructions for a heated coated windshield each of which could be used in the embodiments of the present invention.

Several elements are common to more than one drawing and where appropriate the same reference numeral is used to identify these common elements.

Figure 1 shows a windscreen 1 having a coated area 2 bounded by dashed line 3. The boundary of the coated area is shown by the dashed line would normally be masked by a black print commonly known as a obscuration band. That print is not shown for reasons of clarity . Busbars 4 and 5 extend along the top and bottom edges of the glass and are connected to an electrical power circuit (not shown). A transmission window 6 is not coated and thereby allows the transmission of radiation through the glass.

In use the temperature of the coating in the areas marked X and Y may be higher than that of the surrounding area. Transmission window 6 is obstructing the even flow of current between the central portions of busbars 4 and 5.

Figure 2 shows windscreen 1 having coated area 2 bounded by dashed line 3 and a transmission window 6 located within the coated area 2. Busbar 5 runs along the bottom edge of the glass and is in contact with the coated area 2. The coated area 2 is divided into three separate zones 7, 8 and 9 by divisions 10 and 11 which extend vertically across the coated area. Divisions 10 and 11 are not shown to scale in order to illustrate the invention. Busbar 4 extends across the top edge of the coating in zone 7 and then passes round three sides of transmission window 6 before extending across the top edge of zone 9. Transmission window 6 is contained entirely within zone 8. Busbar 4 is routed around window 6 via division 10, across zone 8 at a point just below window 6 and returns to the top edge of the coated area 2 via division 11.

In use the application of the same voltage between busbars 4 and 5 as was postulated in relation to Figure 1 will result in the even flow of current between the busbars in zones 7 and 9 and the attainment of a temperature similar to that which might be reached in the same areas of the conventional screen of Figure 1. In zone 8 the distance between the busbars is smaller and hence the resistance is less. The current flows evenly between the busbars in zone 8. However the temperature in this zone will be higher than that in neighbouring zones 7 and 9 because of the increased flow.

Figure 3 shows a windscreen 1 having a coated area 2 which is divided into three zones 7, 8 and 9 by divisions 10 and 11. A transmission window 6 is located within zone 8. Busbar 4 passes around three sides of transmission window 6 and comprises resistors 12 and 13 positioned one at each side of the transmission window within or substantially within the divisions 10 and 11.

In use the introduction of resistors 12 and 13 reduces the voltage applied across zone 8 compared to that which is applied across zones 7 and 9. The temperature reached in zone 8 is determined by voltage and can be adjusted by appropriate selection of the size of resistors 12 and 13.

Figure 4 shows a laminated windscreen comprising an outer glass pane 41 and an inner glass pane 42. Obscuration bands 43 and 44 are printed on the inner surface of panes 42 and 43. Busbar 45 is situated on top of obscuration band 43. Coating 46 is located on top of busbar 45 and band 43 and extends across the inner surface of pane 41. Panes 41 and 42 are connected by PVB interlayer 47.

Figure 5 shows a laminated glass comprising the same integers and having an alternative construction. Coating 56 is located on top obscuration band 53. Busbar 55 is located on top of Coating 56.

Figure 6 shows a laminated glass comprising the same interlayers having a second alternative constriction. Busbar 65 extends beyond the extremity of obscuration band 63 and is in contact with the inner surface of pane 61. Coating 66 is located on top of bus bar 65.

In practice the constructions of Figure 4 and Figure 6 are more readily attained using a silver conducting enamel to form the busbar. The construction of Figure 5 is suited to the use of a metal foil busbar.

These laminated glazings are illustrated by way of example. Other constructions are known and could be employed in the glazings of this invention.

CLAIMS

1 An electrically heated glazing comprising at least one pane of glazing material having an electrically conductive coating on at least one surface thereof and at least two busbars in electrical contact with the coating characterised in that the coating in the area between the busbars is divided into at least two separate zones each zone being electrically isolated from the neighboring zone or zones and the busbars are positioned so as to permit the even flow of current between them.

2 A glazing according to claim 1characterised in that the temperature reached in each separate zone of the coating is regulated by controlling the voltage applied between the busbars in each zone separately.

3 A glazing according to either of claims 1 or 2 characterised in that the coating comprises at least one discontinuity which functions as a transmission window.

4 A glazing according to claim 3 characterised in that the transmission window is located at the periphery of the glazing.

5 A glazing according to claim 3 characterised in that the transmission window is not adjacent to the periphery of the glazing.

6 A glazing according to either of claims 4 or 5 characterised in that the busbar which is located closest to the transmission window passes around the transmission window.

7 A glazing according to any of claims 3 to 6 characterised in that the transmission window is entirely located in a single zone in the coating.

8 A glazing according to any of the preceding claims characterised in that the divisions between the zones are substantially parallel with one another and that the zones are substantially trapezoidal in shape.

9 A glazing according to any of the preceding claims characterised in that the regulation of the voltage across each zone of the coating is achieved by means of varying the resistance of at least one of the busbars.

10 A glazing according to claim 8 characterised in that the resistance of the busbar in increased at the edges of the zone in which the transmission window is located .

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Application No:	GB 0220635.7	**Examiner:**	Bill Riggs
Claims searched:	1 - 10	**Date of search:**	18 February 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1, 2, 3 at least	EP 0524537 A2	(PPG Industries) see particularly p.5 ln 55 - p.6 ln.33 and figs 2 & 3
X	1	US 5446576 A	(Donelly Corp) see particularly abstract and fig.8
X	1 at least	GB 2186769 A	(Nippon Sheet Glass) see whole document, particularly fig.11
A		EP 1168888 A2	(Nippon Sheet Glass) see whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{V}:

H5H

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

H05B

The following online and other databases have been used in the preparation of this search report:

Online databases: EPODOC, JAPIO, OPTICS: H5H, WPI